The Experiments: Part I

The following projects are provided by the Charles Edison Fund: A Philanthropic Foundation. They are recommended for use in **Grades 4 - 5**. These projects are from their booklet, "The Best of Edison" and are reprinted with permission.

Hot Water

Making water hot takes energy...lots of it. A typical family uses 15-20 million Btus of energy each year to heat water for washing everything from hands to dishes. It takes about 168 gallons of fuel oil, 19,900 cubic feet of natural gas or 4,500 kilowatt-hours of electricity to do the job.

The next two experiments have an important thing in common: they both show us how we may be wasting energy unintentionally.

Project #1: Should You Shower or Take a Bath?

MATERIALS:

- Your Bathtub
- 1 Yardstick
- 1 Bar of Soap (optional)

Here's a surprising fact. If people who took baths took showers instead, we'd save a lot of energy. This experiment demonstrates what we mean.

Start by taking a bath. Fill your bathtub with water as usual, but before you step in, use your yardstick to measure the depth of the water in the tub.

Next, take a shower (better wait until you really need one!). Before you begin, though, do something unusual. Close the bathtub drain so the shower water will collect in the tub. When you are finished (take your time!), measure the depth of the water that has collected. Compare this reading with the bath water depth.

You will find that your shower used substantially less water...probably less than half as much! A lot of this water is hot water. As a rule of thumb, figure that it takes an ounce of oil (or a cubic foot of gas, or 1/4-kilowatt-hour of electricity) to heat a gallon of water. So you can see that showering saves lots of energy.

Project #2: A Little Drip Means a Big Energy Waste

MATERIALS:

- An Eight-ounce Graduated Measuring Cup
- 1 Pencil
- Paper
- 1 Faucet
- 1 Clock

Drip...drip, drip...goes the leaky faucet. Each drop of water is tiny, but add all the drops together and you end up with thousands of gallons of water dripping from the faucet each year. If hot water is dripping down the drain, you are wasting more than clean water...you are throwing away the energy used to heat that water.

Here's an experiment that shows you how serious the problem is. If you have a leaky faucet, use it. Otherwise, adjust your kitchen sink faucet (cold water, please) to produce a steady drip...drip...drip.

Place the measuring cup underneath the dripping faucet, and collect 15 minutes worth of drips. You might, for example, collect four ounces of water in 15 minutes.

Now you have to do some arithmetic to find out how much energy was wasted. Get your pencil and paper (and your thinking cap). We'll use the four-ounce figure in the example below:

- **Step 1:** Multiply the number of ounces of water you collected by 4 – this gives you the number of ounces per hour leaking through the faucet.

  4 ounces X 4 = 16 ounces per hour

- **Step 2:** Multiply the answer from Step 1 by 24 – this gives the number of ounces per day leaking through the faucet.

  16 ounces per hour X 24 = 384 ounces per day

- **Step 3:** Multiply the answer from Step 2 by 365 – this gives the number of ounces per year leaking through the faucet.

  384 ounces per day X 365 = 140,160 ounces per year

- **Step 4:** Divide the answer from Step 3 by 128 – this gives the number of gallons per year leaking through the faucet.

  140,160 ounces per year ÷ 128 = 1,095 gallons per year

That's a lot of water. And if it was hot water dripping, it took a lot of energy to make it hot. You can figure out approximately how much oil, gas or electricity was wasted by doing the following calculations:

- **For an oil-fired water heater:** Divide the answer from Step 4 by 110 – this gives the approximate number of gallons of oil wasted.

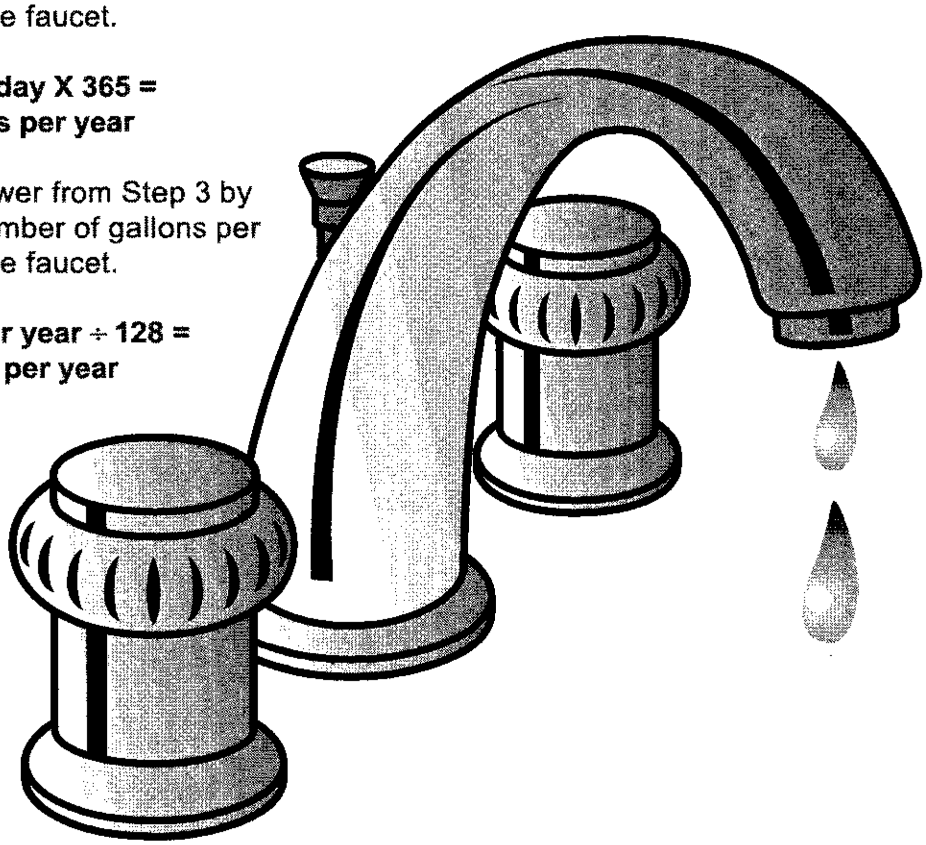
  1,095 ÷ 110 = 9.95 gallons of oil per year

- **For a gas-fired water heater:** Multiply the answer from Step 4 by 1.2 – this gives the approximate number of cubic feet of gas.

  1,095 X 1.2 = 1,314 cubic feet of gas per year

- **For an electric water heater:** Multiply the answer from Step 4 by 0.25 – this gives the approximate number of kilowatt-hours of electricity wasted.

  1,095 X 0.25 = 274 kilowatt-hours per year



Here's an interesting fact. A typical American family uses more energy to heat their home in winter than for any other purpose except powering their automobile. "Space heating" (that's the technical term) uses more than one-fourth of an average family's total energy budget. That's more than 100,000,000 Btus! It's equivalent to more than 800 gallons of oil or 100,000 cubic feet of natural gas.

The following experiment will teach you a lot about keeping heat where you want it...which, after all, is the secret of conserving energy used for space heating. You see, during the winter, you want to keep heat *inside* your home. The better job you do, the less fuel you have to burn.

If your home is air conditioned, the same thing is true...in reverse! During the hot summer months, the idea is to keep the heat *outside*. By doing this, you cut down on the energy needed to run your air conditioner.

Project #3: How Does Insulation Work?

MATERIALS:

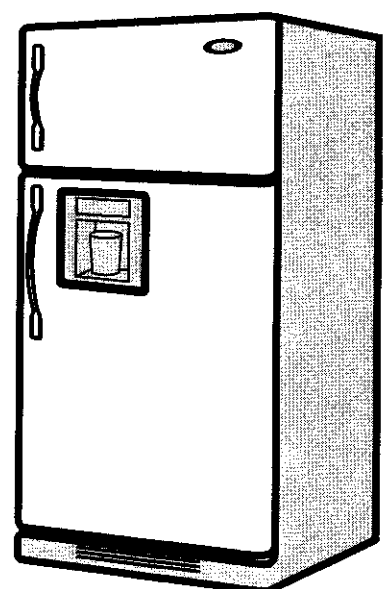
- 1 Small Water Glass
- 1 Inexpensive "Fish Tank" Thermometer
- 1 Cardboard Box *(find one made out of corrugated cardboard; it should be just big enough to hold the water glass)*
- 1 Handful of Cotton Balls

During the winter, the insulation in your home's walls slows down the movement of heat from indoors to the cold outdoors. To understand how insulation works, you must first study how quickly heat will flow from a warm object to cold air when no insulation is present.

Fill the glass with water that is at room temperature (about 70°F); use your thermometer to measure the exact temperature. Put the thermometer into the glass, then place the glass inside your refrigerator. Check the water temperature every five minutes.

You will find that the water temperature drops quickly...probably three or four degrees every five minutes. The reason, of course, is that heat is flowing out of the relatively warm water and into the relatively cold surrounding air inside the refrigerator.

Now let's add some insulation. Here's how. First, refill the glass with water at room temperature. Then, place a layer of cotton balls inside the bottom of the cardboard box, and rest the glass on top of the layer of cotton. Finally, pack the empty space between the glass and the sides of the box with cotton balls. Put the thermometer in the glass and measure the exact temperature. Place the glass, cotton and box in the refrigerator and the temperature every five minutes. You'll find that the temperature will drop much less quickly this time...maybe only a degree or so every five minutes. The cotton insulation is slowing down the loss of heat from the water in the glass.



The insulation in your home's walls is not made of cotton (it is probably made of fiberglass), but it works much the same way.

You may be surprised to learn that many homes are poorly insulated – they have no insulation in their walls and ceilings, or too little to effectively slow down the movement of heat from inside to outside. Because of this, their owners must burn more fuel in order to stay warm. This is a major cause of energy waste.

The next chance you get, go on a "scavenger hunt" around your home for things that use energy. You'll probably find several dozen electric lights (don't forget the bulb inside your refrigerator!), a dozen or more different appliances (refrigerator, TV, toaster, washing machine, etc.), a few electric clocks, a stereo and maybe even an electric toothbrush.

It has been estimated that a well-equipped home consumes more than 35,000,000 Btus of energy each year keeping these "energy eaters" well fed.

A lot of this energy is wasted. That's bad news. But here's the good news: It's easy to conserve much of the energy we are currently wasting.

ELECTRICAL APPLIANCE ENERGY TABLE

Appliance Wattage Rating	Kilowatt-Hrs. of Energy Used Hourly	Ounces of Oil Burned Hourly	Ounces of Coal Burned Hourly
10	1/100	1/10	13/100
25	1 /40	1/4	33/100 (or 1/3)
40	I /25	2/5	1/2
60	3/50	3/5	4/5
110	1/10	1	1 and 1/3
150	3/20	1 and 1/2	2
200	I/5	2	2 and 2/3
300	3/10	3	4
500	1/2	5	6 and 2/3
750	3/4	7 and 1/2	10
1000	1	10	13 and 1/3
1500	1 and 1/2	15	20
2000	2	20	26 and 2/3
5000	5	50	66 and 2/3

The following two experiments will turn you into an energy-saving expert. But before you begin, let's spend a few moments discussing how you can determine how much energy each of the electrical appliances in your home uses. It's really very easy. All you have to do is look on the back or bottom of the appliance to find the electrical "ratings" information. You will see a group of numbers pretty much like the numbers in the chart on this page.

Ignore all the numbers *except* the wattage rating. This number is the key to energy consumption.

Once you have an appliance's wattage rating, consult the table on the left. It tells you how much electrical energy (measured in kilowatt-hours) the appliance consumes during *one hour* of operation. The table also tells you roughly how much oil or coal was burned at your power station to produce this amount of electrical energy.

Be sure you ask for permission before you turn over any kitchen appliances, and don't try to move big appliances without help from an adult.

Project #4: Does Your Clothes Dryer Waste Energy?

MATERIALS:

- About an Hour of Spare Time on Washing Day
- 1 Clock

The heart of a clothes dryer is a source of hot air. Wet clothes tumble through the hot air and are dried. It takes many thousands of Btus of energy per hour to heat the air – so we should never run a clothes dryer unnecessarily.

However, many people do just that. They set the dryer's timer for longer than is necessary, and the machine rumbles on long after the clothes inside are completely dry.

This simple experiment will tell the tale. Start by getting permission. Learn how to restart the machine after you stop it by opening the door. Now you are ready to begin.

The next time there is a load of clothes in the dryer, pull up a comfortable chair and start watching the clock. After fifteen minutes goes by, open the dryer door, wait for the drum to stop turning, then feel the clothes (careful...they may be hot). They will probably still be damp. Close the door and restart the dryer.

Do this again every five minutes until the clothes feel dry to your touch. Look at the timer and see how much longer the dryer was set to run. If your dryer is electric, you can figure that every wasted minute burned about 4/5 ounce of oil (or one ounce of coal) back at the power company. If your dryer runs on gas, figure that every wasted minute burned about 1/10 cubic feet of gas.

Here are two other energy-saving tips for dryers:

- Make sure the lint filter is cleaned every time the dryer is used.
- Don't dry "half loads" – make sure the machine is full before using it.

Project #5: Checklist for Energy – Efficient Lighting

MATERIALS:

- 1 Yardstick or Tape Measure
- 1 Pencil
- Paper

How much energy is used to light your home? Your household probably uses about 2,000 kilowatt-hours of electrical energy each year. Your local electric power plant burns about 150 gallons of oil (or more than 3/4 ton of coal) to generate that much electricity.

With this much energy "going up in light," it makes good sense to learn to use lighting efficiently. This simple lighting checklist will give you a head start. Walk through your home – with pencil and paper in hand – and see how well the lights in your home measure up. Tell your parents about your findings.

Are bulbs and lampshades free of dust and dirt that block light transmission? Dirty bulbs and shades waste the light produced inside the bulbs. As a result, you may turn on two lights when only one is really necessary.

Are lampshades translucent (so light can pass through them) rather than solid? It doesn't make sense to use energy to produce light and then block the light with a solid lampshade.

Are ceilings and walls light-colored? Light colors reflect more light than dark colors, so fewer lamps (or lower-wattage bulbs) can be used to light the room.

Are "non-critical" lighting levels in your home kept as low as possible? As a rule of thumb, one watt of lighting per square foot of floor area is adequate for general room and hallway lighting. Use your yardstick or tape measure to measure the floor space of rooms and halls. Check the wattage of the bulb(s) in the room to see if the lighting level is too high. For example, a 100-watt bulb in a 50-square-foot hall is too much. Of course, "critical" tasks (such as reading, sewing, building model airplanes and doing your homework) require more light.

Does every member of your family turn off lights after he or she leaves a room? Not doing this is an out-and-out waste of valuable energy!

You may hear some people say they purposely leave lights on. These people mistakenly believe that the sudden surge of electricity that flows through a light bulb when it is turned on represents a lot of energy. They think keeping the bulb lit – and thereby avoiding starting surges – somehow saves energy. They are wrong. A light bulb consumes less energy during its starting surge than during a single second of normal operation. Always turn lights off when they are unnecessary, even if it's only for a few seconds.

Turn trash into energy? Yes indeed. Many cities across the United States are doing just that. The idea makes good sense.

After you complete this project, you will see that much of the waste we discard every day can be burned to produce heat. In turn, this heat can be used to generate electricity in a power plant.

But combustible materials are only part of the story. We also discard organic wastes (such as food scraps) that can be transformed into methane gas, the main component of natural gas. In this way, our garbage can help supplement America's natural gas supply.

According to the U.S. Environmental Protection Agency, more than 6 billion tons of waste of all kinds are produced in America each year. A large portion of this mind-boggling heap contains recoverable energy that never gets recovered. That's a lot of energy going to waste...in waste.

As you might expect, converting waste products into energy is an expensive process, particularly when it is done on a large scale. However, waste conversion kills two birds with one stone. First, it provides us with needed energy. Second, it save valuable landfill space. For both of these reasons, many experts predict waste conversion will become very popular in the years ahead.

Project #6: Turning Trash into Usable Energy

MATERIALS:

- A Pair of Gloves
- Household Trash (see text)
- A Shallow Baking Dish
- Aluminum Foil

As we said earlier, many of the things we throw away every day can be burned to produce heat. They are a source of energy. This simple experiment proves the point. It shows one way of converting trash into fire fuel.

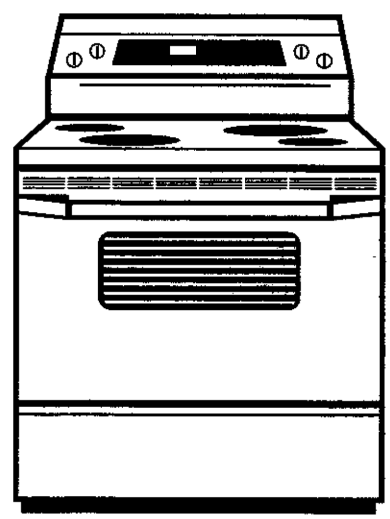
The first step is to put on a pair of gloves and rummage through your trash cans. Look for paper or cardboard items that aren't too dirty or messy. For example:

- Paper cups or plates;
- Paper toilet tissue wrappers;
- Paper towels; and
- Flour or sugar bags.

You get the idea...the list can go on and on.

Using scissors, cut these items into pieces that will fit neatly into the baking dish. But don't put them into the dish yet. First soak them in warm water until they are soggy. While the paper pieces are soaking, line the dish with aluminum foil to keep it clean.

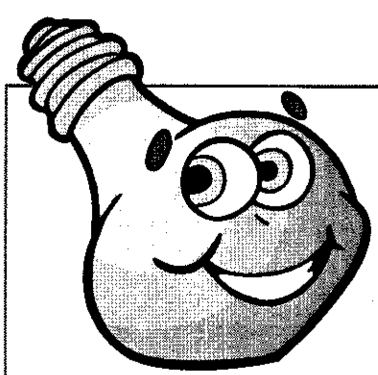
Then place layer after layer of soggy paper into the dish. Use your fingers to press the layers together and to force the excess water out of the soggy mass. Pour this excess water out. Stop adding layers when you've built a pile that's about 3/4 inch thick.



Now we want the compressed pile to dry out. For this demonstration only, let's speed up the drying process by using an oven (better check to see if it's OK to use the oven for this purpose). Bake the pile for about an hour. The oven temperature should be around 200°F. DON'T USE A MICROWAVE OVEN. Because of the aluminum foil, the microwave tube inside the unit could be damaged.

After taking the dish out of the oven and letting the contents cool down, lift the pile out of the dish. If it is still damp, set it aside until completely dry. When dry, chunks of this salvaged waste paper will burn like wood. You can use them in a fireplace, campfire, or wherever.

When making additional piles, skip the oven part. (You don't need the baking dish either; use something else.) Simply let the piles dry outside in the aluminum foil liner. It doesn't make sense to consume more energy using the oven than you get from the fire fuel.



Here's an IDEA...

Before you begin a project, ask your teacher which categories will be judged at your regional science fair competition.